the gill region in breathing but is taken in at the mouth and forced backward over the gills and out in a backward direction. Secondly, there are certain types of fishes which possess no pectoral fins and yet manage to keep up their supply of oxygen. Thirdly, there are certain fishes which live upon the bottom, like the skates, or even buried under the sand, as the flounders, which are unable to make any such use of the pectorals and yet breathe without difficulty. Lastly, it is a point of observation without a single exception in my experience that the ordinary, actively swimming type of fish when resting on the bottom does not move the fins at all. Observations of several years' standing, on fishes in and out of aquaria, have recently been supplemented by careful studies at the New York Aquarium on many different types of fishes, both fresh water and marine, and the result is invariably as above stated.

On the other hand, all the fishes that I have observed use the pectorals when they are suspended in the water. Moreover, other fins are often brought into use at the same time. Thus the elongate pike (*Lucius*) and gar (*Lepisosteus*) are seen to move the pelvic fins slowly, coordinately with the pectorals, and short-bodied forms such as the butterfly-fish (*Chætodon*) move the pectorals and caudal, while in species intermediate in form the caudal, anal and dorsal may, any or all, be used in addition to the paired fins when suspended in the water. This array of facts makes it quite clear that the function of the pectorals when the fish is stationary is that of equilibration and not the removal of water charged with carbon dioxide.

It is impossible to formulate a rule for the pectoral fins which will cover all cases, since in the more or less aberrant species this fin may be used for creeping on the bottom or even for progress on land or in the air, or it may enter into the formation of a sucking disc, or rarely may be absent; but as far as the usual swimming type of fish is concerned, the following uses are most in evidence:

Guiding and balancing the body in swimming;
To act as a brake in arresting the progress;
Equilibration when suspended stationary in the water, and
Locomotion, either forward or backward.

The pelvic fins are generally used much in the same way as the pectorals, though of less importance. The vertical fins may assist the caudal in locomotion or the pectorals in balancing. In terete types of fishes the dorsal and anal seem to have much the same function as a centerboard on a boat, to prevent the body from slipping sidewise through the water when the caudal portion is flexed in making the stroke. In fishes of this type which have had these fins removed the body is seen to wriggle to a greater extent than in those which possess the fins.

In conclusion, I wish to say that no one appreciates better than the writer the highly adaptive character of the fins, especially those of teleosts, and that any one who searches for exceptions will find them—it would probably be much more difficult to find two species in which all the fins are used in exactly the same manner—and yet I believe that the general functions of the fins are about as above outlined.

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COLUMBIA UNIVERSITY,
January 18, 1906.

## COLUMBIA FIELD WORK IN 1905 INTERCOLLEGIATE FIELD COURSES IN GEOLOGY.

DURING the latter part of May and early part of June, 1905, a party of nine graduate students from the department of geology, Columbia University, under the guidance and direction of Professor A. W. Grabau, made a somewhat extended field trip through New York State, visiting and studying in considerable detail many of the type localities and typical developments of the Paleozoic formations. The object of the trip was, by actual field work, to make each student familiar with the general appearance and lithological character of the various formations as they occur in the field, as well as their stratigraphical relation to one another and to the underlying crystalline rocks, and by personal collecting, to make him familiar with the characteristic fossils of each formation. Whenever opportunity was afforded a study was also made

of structural, tectonic and physiographic features.

The party left New York on May 20, and made its first stop in the vicinity of Rondout and Kingston. Here, in the exposures laid bare in the quarries of the Vlightberg Hill, on the North Hill, and along the railroad tracks toward Whiteport, Binnewater and Rosendale, excellent exposures were found of the Ordovicic (Hudson River group), unconformably overlain by the Siluric, including the Schawangunk conglomerate, Binnewater sandstone, Rosendale cement, Cobleskill limestone, Rondout waterlime and Manlius limestone. These are in turn conformably overlain by the lower and middle Devonic, namely, the Coeymans limestone, New Scotland shale, Becraft limestone, Port Ewen limestone, Oriskany sandstone and limestone, Esopus grit and the Onondaga limestone. The Siluro-Devonic contact between the Manlius and Coeymans is so sharp and distinct that a member of the party secured a hand specimen Siluric at one end, Devonic at the other and the dividing line clearly marked in the middle. A careful study was also made of the structural features of this region, including the overthrust fault and repeated formations of the Vlightberg and North Hill described in the Report of the New York State Paleontologist for 1902.[1]

The next stop was made at Hudson, whence visits were made to the Hudson River shales at Mount Merino and to the various formations exposed at Becraft Mountain. At Becraft Mountain upon the upturned and eroded Hudson shales is deposited the Manlius limestone and this is followed directly and conformably by the Coeymans, New Scotland, Becraft, Port Ewen, Oriskany, Esopus, Schoharie and Onondaga. Each of these formations was studied in considerable detail and characteristic fossils were collected. Attention was also called to the tectonic features of the mountain and the tendency of streams to flow and swamps to form at the contact between the Oriskany and overlying Esopus beds.

[1] New York State Museum Bull. 69, pp. 1063–1065, by A. W. Grabau, and pp. 1176–1227; by Gilbert Van Ingen and P. Edwin Clark.

Passing on to Schoharie, a day was devoted to the study of the Siluric and Devonic formations as exposed there. A part of the time was spent in carefully studying and collecting fossils from the formations exposed from the bottom of the Schoharie Creek to the summit of West Mountain. In the bed of the creek were found sandstones of the Hudson group, and resting upon these were the Salina sandstones (Binnewater) and shales (Brayman). From this as a starting point we ascended the West Mountain and in doing so passed over and examined the Cobleskill, Rondout and Manlius of the Siluric; the Coeymans, New Scotland, Becraft, Port Ewen, Oriskany, Esopus, Schoharie and Onondaga of the Devonic, the Onondaga limestone forming the hard resistant capping of the mountain. This locality furnished a splendid illustration of the behavior of the various formations under weathering, the hard resistant limestones forming cliffs while the shales and softer beds formed wooded or cultivated slopes. Later in the day the party visited and carefully examined the formations exposed in the limestone quarries east of the village.

A short stop was made at Little Falls to examine the Beekmantown limestone and its contact with the underlying crystalline rocks and to note the peculiar physiographic features of the Mohawk Valley at this point. Then the party moved on to Utica, whence trips were made to Trenton Falls and Washington Mills. At Trenton Falls the Trenton beds were carefully examined in the walls of the gorge and fossils were collected both from the beds in place and from the material excavated and thrown out by the Utica Electric Light and Power Company when installing their plant at the side of the river. At Washington Mills were found excellent exposures of Utica shale and lower Loraine, and resting disconformably[2] upon the latter the Oneida conglomerate, which in turn is succeeded conformably by the Clinton beds. These Clinton beds were studied in the gorge of Swift Creek, the type locality.

At Pulaski, along the gorge of Salmon

[2] Grabau, Science, N. S., Vol. XXII., pp. 534, 1905.

River, a few miles from Lake Ontario, were found extensive exposures of the upper Loraine shales, and these in certain layers were found to be very fossiliferous.

From Syracuse a short trolley trip was made to the Solvay quarries at Split Rock and the upper Siluric and lower Devonic formations were examined, and the Siluro-Devonic contact noted. Owing to the fact that this trip was made on a very wet afternoon, no detailed work was done.

From Syracuse a side trip was also made to Tully, where the type locality of the Tully limestone was visited, and fossils were collected from the *Hypothyris cuboides* fauna, famous as representing the mingling of European and American faunas at the beginning of upper Devonic time. The Moscow shale, underlying the Tully limestone, was examined and many fossils collected from it where it is exposed near the Solvay salt wells, a few miles from Tully village. Tinkers Falls, some six or eight miles from Tully, was visited. Here a small creek has cut a gorge through the black Genesee shales above and falls over the edge of the exposed Tully limestone. This limestone, some twenty or thirty feet thick, projects out from the cliff for nearly thirty feet, the soft Moscow shales below having been eroded away.

At Rochester the party made a short stop and hasty examination of the lower Siluric formations as exposed in the Genesee gorge, and then went on to Niagara Falls and vicinity. Here a very careful study was made of the Medina, Clinton, Rochester and Lockport formations, and many fossils were collected from them. An attempt was made to picture the region as it was in preglacial time, when the watercourses were very different from what they are now, and to understand the cause and meaning of the physiographic features now existing. After spending several hours at the Upper Rapids, Goat Island, the Lunar and American Falls, the party followed the gorge along the American side, walking down the tracks of the New York Central Railroad as far as Lewiston. Then a car was taken up the Canadian side and stops were made at the Whirlpool Rapids, and at some of the best points for viewing the Horseshoe Falls.

After completing the work at Niagara, the party went south to Eighteen Mile Creek and the shore of Lake Erie. Eighteen Mile Creek was followed from the Lake Shore Railroad bridge to where it empties into Lake Erie, then we walked along the Lake Shore section for several miles to both the north and south of the creek. Here were found excellent exposures of the Hamilton and Portage groups, including the Ludlowville shales, Encrinal limestone, Moscow shale, Styliolina limestone, Genesee, Middlesex, Cashaqua and Rhinestreet shales. An abundance of fossils was collected from most of these beds, and many of the beds were followed for miles along their excellent and continuous outcrops.

From Buffalo short trips were made to Lancaster, Williamsville and North Buffalo. At Lancaster the Stafford limestone was found and many fossils collected from it. The peculiar position of this limestone between two beds of middle Devonic shale was carefully examined in an endeavor to understand why it was there and how it was caused—whether by change of sedimentation or continental oscillation. The party saw evidence of the fact that after Onondaga time there was a gradual shoaling of the waters over central and western New York, as is indicated by the deposition of shales instead of limestones. Twice during Marcellus time there was a return of pure water conditions, with an invasion of a western fauna. One of these is marked by the Agoniatite limestone and the other by the Stafford limestone.

At Williamsville were found the Bertie and Cobleskill (Greenfield), with the Onondaga resting disconformably upon the latter. In the Onondaga, where it was being quarried, was found a most perfect example of a Paleozoic coral reef. The reef in the center of the quarry was made up of massive coral heads, some of them five and six feet across. On either side the bedding planes sloped gently away from the center of the reef. Quarrying operations were stopped when the reef was reached because the massive unstratified limestone could not be readily worked.

In the quarries at North Buffalo the disconformity between the Bullhead and Onondaga was studied. This time-gap is faintly marked, but very careful study has shown that a thin layer of sandstone, in some places hardly more than a single layer of Quartz sand grains, lies between the two disconformable formations. In one place there is a remarkable dike of the intervening sand injected into the underlying formations, extending clear through the Bull-head into the Bertie.

On the return trip from Buffalo to New York the party made one stop at Portage to examine the upper gorge of the Genesee River, and the upper Devonic formations exposed there. Members of the party who desired to do so then joined the students from the School of Mines for a week's field work in the region about Newburgh, where the crystalline rocks of the Highlands and the stratigraphy and structure of the Skunnemunk Mountain region were studied and mapped in detail.

Thomas C. Brown.

Columbia University.

## PRELIMINARY NOTE ON THE EMBRYOGENY OF SYMPLOCARPUS FŒTIDUS SALISB.

Last year Mr. W. H. Lippold, while engaged in graduate work in the botanical department of the University of Minnesota, undertook a study of the embryo-sac development and embryogeny of *Symplocarpus fœtidus* Salisb.

The work was not carried to completion, some important points being left undecided because of lack of material. The writer, upon the suggestion of Professor Lyon, has taken up the unfinished work and hopes to bring out in a subsequent paper an account of the observations made.

Some interesting facts have already been established and it seems advisable to call attention to these at the present time. Briefly stated they are as follows:

The gynœcium is almost always one-chambered, although two chambers infrequently occur.

The ovule is solitary, axial, orthotropous and pendant from the roof of the chamber.

The two integuments which are formed do not completely enclose the nucellus.

A massive endosperm develops and rapidly consumes the nucellus, the inner and outer integuments, and pushes back into the basal tissue of the ovule.

The protocorm soon assumes a somewhat campanulate shape with a short, thick suspensor at its narrower, proximal end.

The radicle and plumule are both differentiated at the suspensor end of the protocorm.

The developing protocorm completely consumes the endosperm as well as all the remaining ovular tissue except the base of the hilum, which remains closely appressed to its broad end.

*The embryo, therefore, comes to lie free in the chamber of the gynœcium without any trace of seed coats or enveloping membranes.*

The mature embryo is nearly spherical and measures 8–11 mm. in diameter.

The epidermal and subepidermal cells have their walls considerably thickened, while the walls of the former are distinctly cuticularized.

The metacormal axis is short and bent back upon itself, the plumule lying close to the radicle.

The so-called 'seeds' of *Symplocarpus fœtidus* are naked embryos.

C. Otto Rosendahl.

University of Minnesota.

## LOWER PALEOZOIC FORMATIONS IN NEW MEXICO.[1]

The older Paleozoic strata have generally been considered absent in New Mexico. During the past summer, while engaged in field work for the U. S. Geological Survey, under the direction of Mr. Waldemar Lindgren, the undersigned found Cambrian, Ordovician, Silurian and Devonian formations at various places along a belt which crosses Grant, Sierra and Luna counties, and extends from the east side of the Rio Grande westward beyond the Arizona line and probably connects with the similar formations of the Clifton copper district in Arizona.[2]

[1] Published by permission of the director, U. S. Geological Survey.

[2] W. Lindgren, professional paper, U. S. Geological Survey, No. 43.